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(54) Title
CULTIVATING APPARATUS

(57) Claim

1. Mobile turf cultivating apparatus including a main structure mounted on ground-engaging wheels for movement in a line of travel; tool support means mounted in the main structure in a substantially fixed orientation, but movable bodily in that orientation in a substantially circular path around a horizontally disposed axis for the support means which is substantially at right angles to said line; drive means operatively connected to the tool support means for moving the latter in that path; parallelogram link means depending from the tool support means and pivotally connected thereto about horizontally disposed parallel axes so as to swing in a fore and aft direction along said line of travel under the action or forces generated by movement of the support means in said path under the action of the drive means; the link means carrying at least one cultivating tool at a lower end thereof remote from the support means, the link means maintaining the or each said tool substantially vertical during swinging of the link means under the action of said forces.

2. Apparatus according to claim 1, wherein the tool support means comprises at least one post member which is maintained in a substantially constant orientation during movement thereof in a circular path.

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Complete Specification for the invention entitled:

"CULTIVATING APPARATUS"

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

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The present invention relates generally to cultivating apparatus and is more particularly concerned with apparatus for cultivating turf such as used for golf greens and fairways, recreation areas and sports arenas, bowling greens and the like.

The invention will be hereinafter described with particular reference to the use of the apparatus for turf coring, using a cultivating tool comprising a hollow coring tyne, but the invention is usable with many other types of cultivating tool such as solid spikes, blades and the like. Thus, the particular application hereinafter described and based on the use of such tynes is to be understood as not limiting on the invention.

Due to the nature and properties of turf, its maintenance creates many problems for the greenkeeper. A major problem encountered is that the turf becomes root-bound; the matted roots of the turf becoming so entangled and dense that the turf literally strangles itself and eventually dies. The generally accepted method of overcoming this problem is to remove small cores of turf from the green, thus permitting the remainder to spread out and grow more freely. In the past, several different turf cultivating machines have been proposed, but generally these have suffered from the disadvantages of being extremely complex and thus highly expensive and/or of being slow in cultivating a given area.

It therefore is a principal object of the present invention to obviate the aforementioned disadvantages by providing a turf cultivating apparatus which is of relatively simple construction, operates efficiently and is able to cultivate turf at relatively high speeds.

According to the present invention there is provided a mobile turf cultivating apparatus including a main structure mounted on ground-engaging wheels for movement in a line of travel; tool support means mounted in the main structure in a substantially fixed orientation, but movable bodily in that orientation in a substantially circular path around a horizontally disposed axis for the support means which is substantially at right angles to said line; drive means operatively connected to the tool support means for moving the

latter in that path; parallelogram link means depending from the tool support means and pivotally connected thereto about horizontally disposed axes substantially parallel to said support means axis so as to swing in a fore and aft direction along said line of travel under the action or forces generated by movement of the support means in said path under the action of the drive means; the link means carrying at least one cultivating tool at a lower end thereof remote from the support means, the link means maintaining the or each said tool substantially vertical during swinging of the link means under the action of said forces.

The tool support means may be of any of a wide variety of forms. In one convenient arrangement, the support means is a post or an elongate plate member (herein referred to as a post member). Such post member may be substantially vertical and this is preferred. However, the post member may be at an angle to the vertical. In either case, that is with the post member either vertical or at an angle to the vertical, it is maintained substantially in such orientation during its movement on a circular path. Also, while a single such post member can be used, the tool support means preferably comprises at least two laterally spaced post members. Where two or more post members are provided, they or at least successive ones thereof preferably are out of phase by about 180° in movement in their circular path. For two post members, they preferably are not exactly 180° out of phase; the members, for example, being about 170-175° or about 185-190° out of phase.

The drive means may include a suitable motor, such as a petrol, or an electric or battery, driven motor. However, in an alternative arrangement, the apparatus may be moved by a prime mover such as a tractor, with power to its drive means being derived from a motor of the prime mover. In each case, the drive means may include a crank means rotatable on a transverse axis by a drive connection between it and the motor. In one convenient arrangement, a flywheel in a plane parallel to the path of movement of the tool support means is rotatable by a drive coupling, such as a drive belt, between it and an output member of the motor. In such arrangement, a

stub shaft mounted on or journalled in a major face, but radially offset from the axis of rotation, of the flywheel may comprise or form part of the crank means. Such stub shaft respectively may be journalled in or mounted on the tool support means. A similar such shaft on a face of a slave wheel can be journalled in or mounted on a second support means where two of the latter are provided.

Where the tool support means is movable under the action of crank means, it is necessary that constraining means be provided so that the support means moves bodily in a fixed orientation. The constraining means may comprise a second crank means rotatable on an axis spaced from but substantially parallel to the crank means of the drive means. Alternatively, the constraining means may comprise a cam and a cam follower which interact to limit movement of the support means to bodily movement in such orientation. In a further alternative, the constraining means may comprise a constraining member which itself is constrained to move only in a first direction parallel to the path of movement of the tool support member, with the latter adjustably coupled to the constraining member so as to be movable only in a direction parallel to that path and substantially perpendicular to the first direction.

The link means, in its simplest form, comprises a parallel pair of link members each pivotally coupled at an upper end thereof to the tool support means, and pivotally inter-connected that their lower ends by a connecting member on which at least one cultivating tool is mounted. The link members are laterally spaced in the direction of travel. Also, their coupling to the support means and their connection to the connecting member are such that they remain in parallel as they swing in the fore and aft direction, with movement of the support means in its path, to provide a parallelogram linkage by which the at least one cultivating tool is mounted in relation, and movable relative, to the support means.

The arrangement of the link means preferably is such that, with the support means stationary, the link means hangs under gravity below the support means, with the or each cultivating tool projecting substantially vertically below the

link means. However, as the support means is caused by the drive means to move bodily in its circular path, the pivotal connection between the support means and the link means is drawn on a similar path. That connection thus is drawn so as to cycle upwardly and downwardly and, simultaneously, forwardly during the upper half and rearwardly during the lower half of each cycle. During such cycle, the link means is caused to swing in the fore and aft direction, with the or each cultivating tool being drawn with the link means. However, due to the link means providing a parallelogram linkage between the or each tool and the tool support, the or each tool remains in its vertical orientation.

It is found that the link means swings in the fore and aft directions with a substantially constant amplitude. That amplitude can be acceptable and set the extent of travel of the apparatus between successive turf penetrations by a given tool. However, a fore and aft stop member can be provided to reduce that amplitude, and thus adjust the travel between successive penetrations.

Reference now is made to the accompanying drawings, in which:

Figure 1 shows apparatus according to the invention in a first side elevation;

Figure 2 shows the apparatus in the opposite side elevation to that shown in Figure 1, but with the apparatus in a non-operating condition;

Figure 3 shows the apparatus in front elevation; and

Figures 4 to 6 show on an enlarged scale operating components of the apparatus at various stages during its travel.

In the drawings, there is shown cultivating apparatus 10, having a main structure 12 mounted on a pair of forward wheels 14, a single rear jockey wheel 16. Apparatus 10 is able to be manouvered during forward travel (to the right in Figure 1) by turning wheel 16 by control handle 18. The latter has a post 20 journalled in structure 12 and terminating at its lower end in a yoke 22 in which wheel 16 is mounted.

Structure 12 includes a peripheral frame 24 of

hollow box section, a portion of this which extends across the front end of the machine being cut-away in Figure 3 for ease of illustration. Structure 12 also includes a platform 26 which, with the apparatus ready for use as shown in Figure 1, rests on blocks 28 fixed on transverse bar 30 of frame 24. However, platform 26 has laterally opposed plates 32 at its rear end which are pivotally connected to similar plates 34 of platform 26 by transverse shaft 36. Thus, the forward end of platform 26 is able to be raised from its in use position shown in Figure 1 to a position as shown in Figure 2; this facilitating travel of the apparatus when not required to perform a cultivating operation. Platform 26 is able to be moved between its positions by a manual pivoting of lever 38 and links 40 coupling lever 38 to platform 26. Lever 38 and links 40 have been omitted from Figure 3 for ease of illustration.

On the rear end of platform 26, and to one side of apparatus 10, there is mounted a petrol motor 42 which receives fuel from tank 44. Air filter 46 for motor 42 has been omitted from Figure 3 for ease of illustration. Motor 42 has a laterally extending output shaft 48 which is journalled in upright plate 50 mounted on the opposite side of the apparatus to motor 42.

At the forward end of platform 26, there is a upright plate 52, supported by transverse angle member 53 and having its width dimension extending along the centre line of apparatus 10. Mounted on one side of plate 52, there is a flywheel 54 rotatable on transverse shaft 56 journalled in plate 52. Projecting rearwardly of plate 52, there is a bracket 58, with a respective pulley 60,62 mounted on each side of bracket 58 but rotatable in unison with common shaft 64 journalled in bracket 58. Flywheel 54 is rotatable by a driving connection with motor 42. A first drive belt 66 passes around pulley 68 on and rotatable with shaft 48, and around pulley 60, whole a second such belt 70 passes around pulley 62 and flywheel 54. Belts 66,70 are suitable tensioned by guide wheel 67 carried on arm 69 and bearing against belt 66; arm 69 being biased to provide suitable belt tension by resilient means not shown.

On the outer face of flywheel 54, there is an integral stub shaft 72. Additionally, one the side of plate 52 remote from flywheel 54 ere is a slave wheel 55 rotatable with flywheel 54 on shaft 5:. Wheel 55 also has a stub shaft 73, with shaft 73 being radially spaced from shaft 56 by the same distance as shaft 72. However, shafts 72,73 are circumferentially spaced by slightly more than or slightly less than 180°.

Each of shafts 72,73 is journalled in the upper end of a respective thin post memeber 74,75 each of similar form. Below flywheel 54 there is a follower wheel 76, while a similar wheel 77 is mounted on the opposed side of plate 52, below wheel 55; each of wheels 76,77 being rotatable in unison on a common shaft 78. Also, each of wheels 76,77 has a respective stub shaft 80,81 which is spaced from the axis of rotation of its wheel by the same distance as shafts 72,73 are spaced from the axis of shaft 56; each shaft 80,81 also being journalled in the respective post members 74,75. The arrangement is such that, with rotation of flywheel 54 under the action of motor 42, each of wheels 55,76,77 is similarly rotated due to the inter-engagement provided therebetween by stub shafts 72,73,80,81 and members 74,75. Thus, as flywheel 54 is rotated, members 74,75 are drawn bodily in a circular path but are maintained in a substantially constant orientation.

On the lower end of each post member 74,75, there is depending pair of link members 82,84. The upper end of each member 82,84 is pivotally connected to each member 74,75 by a pivot pin 86,88, with each of pins 86,88 extending transversely and in a common substantially horizontal plane. The lower end of link members 82,84 is pivotally connected by pins 90,92 on a common horizontal plane, to connecting member 94; with member 94 having depending, hollow coring tynes 96 mounted thereon. The relationship between pins 86,88,90,92 is such that members 82,84 are substantially parallel and remain parallel with pivoting of members 82,84 on pins 86,88 relative to their respective one of members 74,75. Tynes 96 project vertically below their member 94 and remain in such orientation with pivoting of members 82,84 on pins 86,88.

Figures 4 to 6 show plate 42, flywheel 54, post member 74 and the latter's link members 82,84 as viewed in Figure 1. However, in the view depicted in Figures 4 to 6, post member 75 and its link members 82,84 should be seen due to wheels 55,77 being out of phase with flywheel 54 and wheel 76 and the absence of a showing of wheels 14. Despite this, member 75 and its link members 82,84 have been omitted for ease of illustration.

The components of Figures 4 to 6, in corresponding to Figure 1, are movable to the right during forward travel of apparatus 10, as indiciated by arrows A. Also, flywheel 54 is driven by motor 42 so as to rotate in the direction of arrows B; wheels 55,76,77 being constrained to rotate in unison in the same direction. With such rotation of wheels 54,76, member 74 is constrained to move bodily in a circular path while held by shafts 56,78 in a constant upright orientation.

As shafts 72,80 move beyond their top dead centre positions, member 74 is moved downwardly as shown in Figure 4 by arrow C and forwardly relative to plate 52. Between rotation of shaft 72,80 from their top, to their bottom, dead centre position, the forward movement of member 74 is reversed, although it still moves downwardly relative to plate 52. At this reversal, link members 82,84 swing forwardly as shown in Figure 4 (although at least the full extent of the swing occurs a little later in the movement of member 74 than shown in Figure 4). However, due to the parallelogram linkage arrangement provided by link members 82,84 and their connecting member 94, tynes 96 are retained in a vertical orientation.

The arrangement is such that, as link members 82,84 reach the forward extent of their swing, the lower ends of tynes 96 are just clear of the turf on ground surface S. Further rotation of shafts 72,80 to their bottom dead centre position (Figures 5), drives tynes 90 fully into the ground, and thereafter extracts tynes 90 from the ground to complete a coring operation. Thereafter, the post member 74 moving upwardly as shown by arrow D in Figure 4, and rearwardly relative to plate 52, link members 82,84 are swung rearwardly, and then return under gravity to a central depending position

prior to swinging forwardly on a further cycle.

The spacing between link members 82,84, and other factors, can be used to regulate the amplitude of forward and rearward swinging. However, it is preferred to have forward and rearward stop members 98, such as shown supported by brackets 99 on post member 74.

During such cycle, post member 75 and its link members 82,84 are performing the same cycle, but about 180° out of phase. With at least such dual post arrangement, it is found that the apparatus is self-propelling and does not require drive to any of the ground-engaging wheels 14,16. Indeed, the apparatus is capable of quite smooth forward travel with an arrangement of two or more laterally spaced post members; the travel resulting from the positive engagement of tynes while penetrated into the ground and the rearward movement of the associated post member relative to plate 52. That is, the apparatus, in effect claws its way along the ground surface. This is achieved even with a single post member but, in this case, the travel is intermittent.

The self-propulsion possible with the apparatus is facilitated by the simple but robust construction, and also by energy stored in the flywheel, despite drive from motor 42 being transmitted simply by belts 66,70. However, a chain and sprocket, rather than belt and pulley, drive can be used if required. Additionally, the apparatus can be directly driven by motor 42, if required. Thus, in one arrangement, shaft 48 is provided with a pulley or sprocket outside plate 50, with a belt or chain, respectively, passing therearound and around a pulley or sprocket rotatable with the associated one of wheels 14. In an alternative arrangement, a hydraulic fluid pump driven by shaft 48 can provide pressurized hydraulic fluid for a hydraulic motor, or a respective hydraulic motor, operable to drive one or more of the ground-engaging wheels; the output of the pump being regulated, if required, by a flow control valve. Such drive from motor 42 can be provided simply for use in transporting the apparatus from one location to another, with plate 26 raised as in Figure 2. However, it can be used during a cultivating operation, and this can be desirable when cultivating soft or uneven ground.

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In an alternative drive arrangement, readily comprehendible from the foregoing, the apparatus may be provided with a conventional coupling by which it is able to be towed by a prime mover, such as a tractor. The apparatus thus may be connectable to the standard three-point linkage of a tractor. In such case, the drive means of the apparatus may be powered by a motor of the prime mover. Thus, in the case of a tractor as the prime mover, pressurised hydraulic fluid, passing via a line from the tractor, can be used to drive a hydraulic motor of the apparatus forming part of the drive means of the latter.

It will be appreciated that the number and arrangment of tynes or cultivating tools on the or each connecting member can be varied, as required. Also, the number of post members comprising the support means and provided in laterally spaced relationship can be increased, as required. Moreover, a fore and aft spaced arrangement, comprising two or more arrays of laterally spaced post members can be used in tandem, if required. Additionally, the overall diameter of the circular path in which the support means is moved can be varied, as required; with corresponding variation in the length of the link means, the cultivating tools and the depth of penetration of the latter.

Finally, it is to be understood that various alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention.

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THE CLAIMS DEFINING THE INVENTION AS FOLLOWS:

1. Mobile turf cultivating apparatus including a main structure mounted on ground-engaging wheels for movement in a line of travel; tool support means mounted in the main structure in a substantially fixed orientation, but movable bodily in that orientation in a substantially circular path around a horizontally disposed axis for the support means which is substantially at right angles to said line; drive means operatively connected to the tool support means for moving the latter in that path; parallelogram link means depending from the tool support means and pivotally connected thereto about horizontally disposed parallel axes so as to swing in a fore and aft direction along said line of travel under the action or forces generated by movement of the support means in said path under the action of the drive means; the link means carrying at least one cultivating tool at a lower end thereof remote from the support means, the link means maintaining the or each said tool substantially vertical during swinging of the link means under the action of said forces.

2. Apparatus according to claim 1, wherein the tool support means comprises at least one post member which is maintained in a substantially constant orientation during movement thereof in a circular path.

3. Apparatus according to claim 2, wherein there is at least two laterally spaced said post member.

4. Apparatus according to claim 3, wherein at least successive ones of said post members are mutually out of phase in movement on their circular path.

5. Apparatus according to any one of claims 1 to 4, wherein said drive means includes a motor forming a part thereof.

6. Apparatus according to any one of claims 1 to 4, wherein said apparatus is adapted to be connected to a prime mover for travel therewith along its line of travel, with said drive means being adapted to derive power from a motor of said prime mover.

7. Apparatus according to claim 5 or claim 6, wherein said drive means includes a crank means rotatable on a

transverse axis by a drive connection between said motor and said crank means.

8. Apparatus according to claim 7, wherein said crank means includes a flywheel rotatable in a plane substantialy parallel to the path of movement of the tool support means, and rotatable by a drive coupling between said flywheel and an output member of the drive means.

9. Apparatus according to claim 8, wherein the crank means includes a stub shaft mounted on or journalled in a major face of the flywheel, eccentrically with respect to the axis of rotation of the flywheel.

10. Apparatus according to claim 9, wherein said stub shaft is respectively journalled in or mounted on the support means.

11. Apparatus according to claim 10, wherein the support means comprises at least two post members, with said flywheel being coupled to a first one of said post members by said stub shaft, there being a slave which is similarly coupled to a second said post member by a further stub shaft.

12. Apparatus according to any one of claims 7 to 11, including means for constraining the support means so that the latter remains in a substantially fixed orientation as it moves bodily under the action of said crank means.

13. Apparatus according to claim 12, wherein said constraining means comprises a further crank means rotatable on an axis spaced from, but substantially parallel to, the crank means of the drive means.

14. Apparatus according to claim 12, wherein said constraining means comprises a cam and a cam follower which interact to limit movement of the support means to bodily movement in said substantialy fixed orientation.

15. Apparatus according to any one of claims 1 to 14, wherein said link means comprises at least one parallel pair of link members each pivotally coupled at an upper end thereof to the support means, and pivotally inter-connected adjacent lower ends thereof by a connecting member on which the at least one cultivating tool is mounted; the link members being mutually spaced in said direction of travel.

16. Apparatus according to claim 15, wherein said link

means hangs under gravity below the support means, with the at least one cultivating tool projecting substantially vertically below the link means; the pivotable coupling between the link members of the link means and the support means being drawn in a circular path with bodily movement of the support means, with the link members thereby being caused to swing in a fore and aft direction substantially parallel to said direction of travel while maintaining the at least one cultivating tool in a substantially vertical orientation.

17. Mobile turf cultivating apparatus substantially as herein described with reference to the accompanying drawings.

DATED: 28 May 1987
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David B Fitzpatrick

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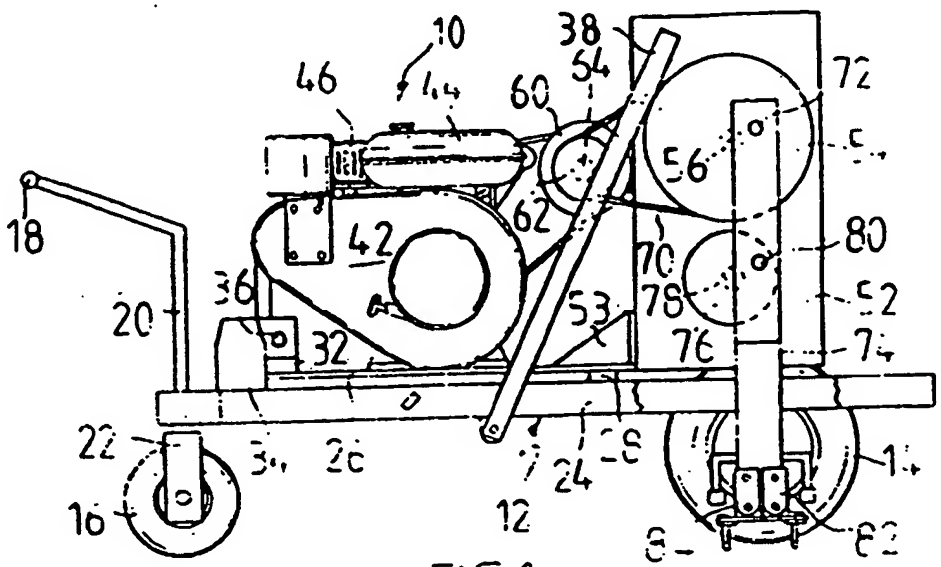
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FIG 1

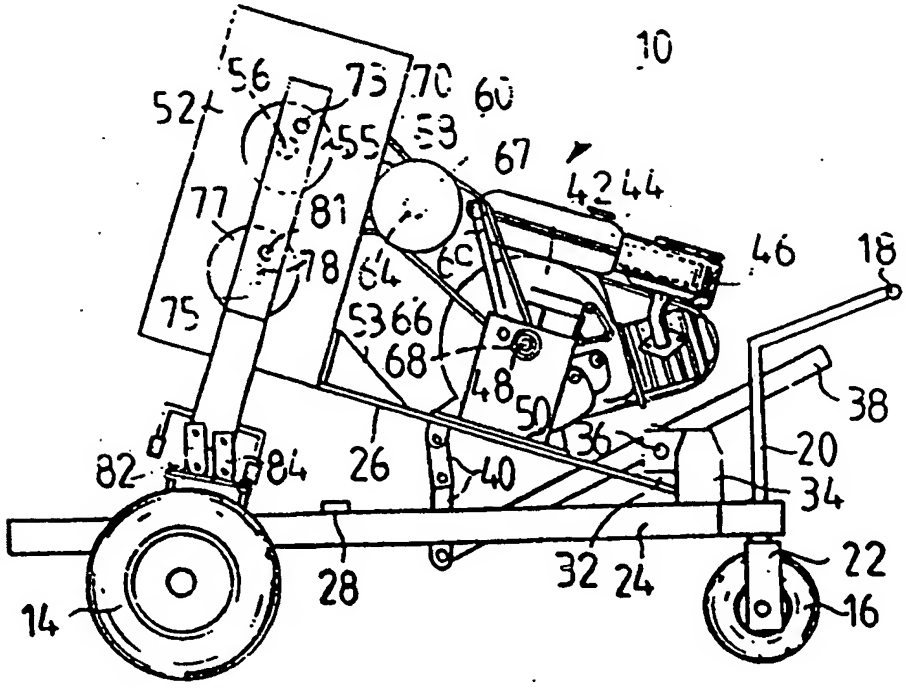
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FIG 2

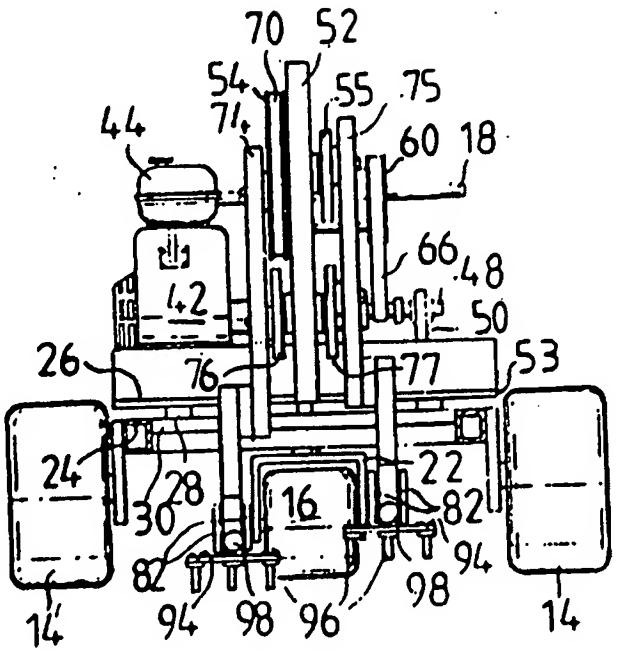

FIG 3

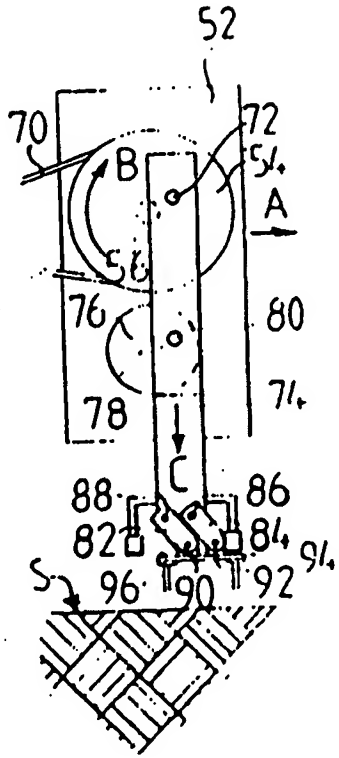

FIG 4

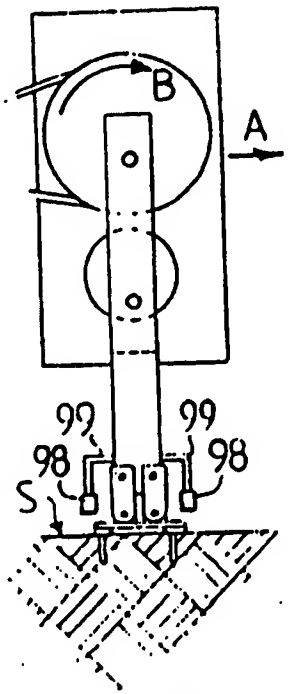

FIG 5

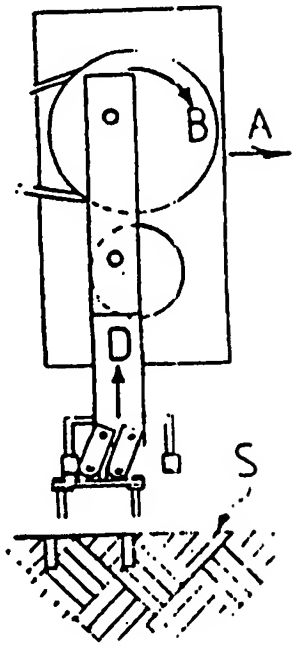

FIG 6

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